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Working Paper

The Possible Scope and Requirements of the Fissile Material Treaty (FMT)

BASIC CONSIDERATIONS

1. In achieving the ideals of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) - namely to prevent the proliferation of nuclear weapons, to achieve the cessation of the nuclear arms race and to achieve nuclear disarmament - control over nuclear weapons materials and the cessation of their production for weapons purposes would be important steps in the complex political and technical process of nuclear disarmament. Nuclear weapons may range in sophistication from fission weapons to boosted weapons, thermonuclear weapons, fission-fusion-fission weapons and enhanced radiation weapons. All require certain specialized materials for their construction. Ceasing the production of such materials could lead to a quantitative capping of the number of weapons in existence and to laying the foundation for their eventual elimination.

2. For the purpose of developing some thoughts on the possible scope and requirements of a fissile material treaty (FMT), the considerations below, are used as a starting point :

   (a) The NPT is the principal motivating treaty with respect to the ideal of nuclear disarmament. Treaties such as the Comprehensive Test Ban Treaty (CTBT) and the FMT are important in complementing and achieving this ideal.

   (b) Articles VI and VII of the NPT recognise the importance of bilateral, multilateral or regional efforts towards the cessation of the nuclear arms race and nuclear disarmament, i.e efforts in parallel to the NPT.

   (c) For pragmatic reasons the International Atomic Energy Agency (IAEA) could be considered as an appropriate Agency for verification of the FMT under certain conditions.

   (d) For practical and political reasons, the declaration of historically produced stocks of weapons materials by all States with nuclear weapons is not believed to be feasible. Materials already declared as excess could be included as a starting point ("baseline") at entry into force of the FMT for a given State with nuclear weapons.

   (e) The continued use of weapons grade material in naval military reactors will require special consideration.

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(f) Tritium is not a fissile material but without tritium many types of modern nuclear weapons will become ineffective. It is consequently considered unlikely that there would be agreement to include tritium in an FMT because of definitional and political problems.

(g) A primary focus of the FMT should be to stop the further production of nuclear materials (in practice certain uranium and plutonium isotopes and perhaps also certain other trans-uranic elements) from which nuclear explosives can be made. Using the term "fissile material" in a generic sense for these weapons materials could cause misunderstanding - in a technical sense "fissile material" has different definitions. A common understanding will have to be agreed for the use of the term.

(h) Although the FMT is intended to be a multilateral treaty, the practical effect of the Treaty will primarily affect only those few States producing, capable of producing or possessing nuclear materials that can be used for nuclear explosive purposes.

THE NPT AND DISARMAMENT

3. In view of Article VI and the relevant objectives contained in the Preamble, the NPT anticipated the cessation of the nuclear arms race and the achievement of the elimination of nuclear weapons.

4. A principal objective of the NPT is nuclear disarmament (along with the objectives of non-proliferation, technical verification, non-proliferation controls and the promotion of the peaceful uses of nuclear energy). Following on the 1995 NPT Review and Extension Conference (NPTREC) and in terms of the document on "Principles and Objectives" adopted there, the CTBT, has already been finalized. A further step in the process, but also an adjunct to the NPT, would be the FMT. The FMT is therefore one of the tools (together with other measures) which would lead to accomplishment of the NPT's objectives.

5. At the 2000 NPT Review Conference, the Nuclear Weapon States gave an unequivocal undertaking to accomplish the total elimination of their nuclear arsenals leading to nuclear disarmament to which all States parties are committed under Article VI.

6. The 2000 NPT Review Conference also agreed on the necessity of negotiations in the Conference on Disarmament on a non-discriminatory, multilateral and internationally and effectively verifiable treaty banning the production of fissile material for nuclear weapons or other explosive devices in accordance with the statement of the Special Coordinator in 1995 and the mandate contained therein, taking into consideration both nuclear disarmament and nuclear non-proliferation objectives. Furthermore, the Conference on Disarmament was urged to agree on a programme of work which includes the immediate commencement of negotiations on such a treaty with a view to its conclusion within five years.

7. Viewed from this perspective the FMT could be relatively simple :

(a) Capturing in an irreversible way weapons material declared as excess in an ongoing

process

(b) Preventing altogether or regulating the further production of weapons-grade materials for legitimate (non-proscribed) uses such as fuel for research reactors, naval reactors, etc

(c) Making "closed-down/decommissioned" production and associated facilities subject to verification to prevent their re-use for weapons purposes.

VERIFICATION

8. For the effective verification of this material, a system comprising of three components are foreseen :

(a) A component dealing with facilities which had previously produced fissile material for nuclear explosive purposes.

(b) A component suitably adapted to weapons grade materials, declared as excess and placed under the supervision of the verification organisation while this material is still in a sensitive geometrical and compositional form.

(c) A component, which will be similar to or the same as IAEA safeguards, dealing with:

- the materials once they have been re-worked into non-sensitive forms; and
- for the production of materials for non-proscribed military uses allowed by the Treaty.

STOCKS

9. If under "stocks" the past production of weapons grade material is understood, then there are both political and practical reasons why a full/complete declaration of such stocks as a requirement of the FMT could be problematic in the negotiations for the treaty as well as for its subsequent implementation.

10. In declaring past production of weapons-grade Plutonium (Pu),even the most transparent of the Nuclear Weapon States (NWS), has in doing so revealed a problem of great practical significance, i.e the fact that no account could be given of about 2 800 kg of Pu - enough to manufacture several hundred nuclear weapons. The practical significance of declaring stocks with such a large discrepancy is therefore questionable. This is a practical problem which was also experienced in the South African case. During the "completeness investigation" in South Africa by the IAEA, the existence of a discrepancy could only be accepted on the strength of other supporting data (i.e other than nuclear materials

accounting), such as operational records, electricity consumption, reports on chemical losses, etc. Considering that South Africa produced a relatively small quantity of HEU over a period of about 15 years, the practical problem of giving an accurate production figure for tens and hundreds of tons of material produced over half a century would present significant practical problems. Declaration of nuclear material in weapons or directly associated with nuclear weapons without the ability to verify the declaration which will be made would therefore not contribute to confidence building.

11. The FMT could address weapons material which has been transferred from military use to peaceful nuclear activities (declared as excess). This excess material would be included in a starting inventory of a State upon entry into force of the FMT (without an obligation to declare its "completeness and correctness" from a production point of view) and would be subject to the verification machinery provided for in the treaty. Further material declared as excess in the future would continuously be added to the starting inventory in an irreversible way.

NAVAL REACTORS

12. The model for Comprehensive Safeguards Agreements (CSA), INFCIRC/153, has since its approval in 1972, contained an Article (Article 14) which allows nuclear material to be withdrawn from safeguards for "non-proscribed military activities".

13. The Article was specifically intended to be applied to nuclear material for naval nuclear reactors using HEU. In practice this Article has never been applied, probably because only the NWS have military naval reactors in operation (nuclear submarines and aircraft carriers) and NWS are not subject to Comprehensive Safeguards Agreements.

14. The need for fuel for naval reactors will exist as long as naval vessels using these reactors exist. The possibility of changing from HEU to LEU fuel is remote, especially for submarines.

15. The obvious conclusion is that an allowance will have to be made in the FMT for military naval reactors - an exception which has also been available for Non-Nuclear Weapon States (NNWS), in principle, for more than 25 years.

TRITIUM

16. Hydrogen has 3 isotopes; hydrogen itself, deuterium and tritium. Deuterium occurs in nature and is separated from ordinary water as 'heavy water' (i.e in the form of its compound with oxygen). Tritium, however, is a radioactive substance with a half-life of about 12 years which is produced in reactors by irradiating an isotope of lithium (Li6) with neutrons.

17. Most, if not all, modern nuclear weapons use tritium, i.e to either boost the yield of an

implosion (Pu) bomb or to combine with deuterium in a fusion reaction in thermonuclear weapons. Without replenishing the decaying tritium from time to time, the effective yield of some nuclear weapons would be drastically reduced.

18. While a ban on the production of tritium would starve certain nuclear weapons from an essential component, leading to the natural 'death' over time of many modern weapons containing this material, it would not eliminate all nuclear weapons. A plutonium or HEU bomb, less effective with regard to yield, can still be made without tritium. The miniaturisation of nuclear devices will, however, be severely handicapped.

19. The need for tritium will, in practice, only disappear to the extent that nuclear disarmament undertakings reach their final objective.

20. The production of tritium in civil nuclear reactors for use in nuclear explosive devices should be prohibited by the FMT.

FISSILE MATERIAL

21. The devastating energy release of a fission bomb is brought about by an uncontrolled nuclear chain reaction of fissioning ('splitting') uranium or plutonium nuclei. The splitting of such a nucleus by a bombarding neutron, releases more neutrons leading to a rapidly escalating chain reaction of fissioning nuclei with the accompanying release of vast quantities of energy. An important aspect, relevant in the context of this discussion, is that the chain reaction in nuclear weapons is associated with metal systems and fast neutrons.

22. In contrast to this the controlled nuclear chain reaction which takes place in a commercial power reactor is the result of slow neutrons. The fast neutrons released in fission reactions are slowed down by collisions with moderator atoms such as hydrogen. The water in the core of a LWR therefore serves two purposes, cooling the reactor and slowing down the neutrons.

23. Certain nuclides can be made to chain react with slow as well as fast neutrons and certain others only with fast neutrons. In addition, many nuclides can be made to fission (split) when bombarded with suitable particles (not only neutrons), releasing energy, but without leading to a chain reaction.

24. The information given in the preceding paragraphs is intended to give the necessary background for appreciating a specific problem with the name of the FMT, i.e understanding what is meant (or intended to be meant) by "fissile material". Various definitions for this term exist in the technical literature. For example, in a 1999 Technical Note of the IAEA, the following definition is given: "All nuclear weapons employ fission energy components. All isotopes of all elements beginning with uranium will fission when struck by a neutron, i.e, they are to some extent fissionable. The fissionability of the isotopes of a given element show marked differences (e.g., 235U is much more

fissionable than 238U). Most heavy nuclei require that the incident neutron has a substantial amount of kinetic energy to induce fission, however, a few heavy nuclei will fission when the kinetic energy of the incident neutrons is essentially zero; such nuclei are said to be fissile. 233U, 235U, 239Pu and 241Pu are the most common fissile nuclides".

25. Without further discussion of the various definitions, it is clear that the term "fissile material" is usually associated with materials chain-reacting with slow neutrons, i.e materials used in power reactors. However, the term also includes weapons materials because materials which chain-react with slow neutrons also do so with fast neutrons. In using the word "fissile" in the FMT, it should be made very clear that it does not include stopping the production of "fissile material" for other than nuclear explosive uses. Without such a qualifier, a ban on production for nuclear weapons purposes could mean stopping the production of commercial reactor fuel and of weapons materials. Whereas it is accepted that it would be difficult if not impossible to change the name of the Treaty at this stage it should be clear that "fissile material" should be defined as addressing nuclear materials that can be made to chain react for the purpose of a nuclear weapon.

OTHER TRANSURANIC ELEMENTS

26. The IAEA has recently shown an interest in the proliferation potential of neptunium (Np) and americium (Am). These elements are formed at very low concentrations in nuclear fuel when irradiated in a reactor and need specially designed industrial scale facilities to separate it from unused uranium or produced Pu recovered in plants which reprocess irradiated fuel, or in plants processing the high level waste resulting from reprocessing. Present quantities of separated Np and Am are small. However, Np is suitable for making a nuclear explosive device (even a relatively simple gun-type device). There is a difference of opinion regarding the credible use of Am for such a purpose due to its physical (not nuclear) characteristics. Np should probably be included in the FMT.

A POSSIBLE MODEL FOR THE FMT

What would remain outside the FMT

27. As long as there is no final agreement on nuclear disarmament, certain activities OUTSIDE THE FMT would continue :

(a) The isotope required for a plutonium device, i.e Pu239, is inevitably accompanied by other isotopes of Pu such as Pu241 and Pu240. Being radioactive some of these decay to americium with a half-life of 14,4 years, which in itself is radioactive. Radioactive decay is accompanied by heat production which is detrimental to the fine engineering tolerances required in the core of the weapon. The plutonium cores of weapons therefore have to be removed from time to time and reworked to remove the americium and other decay products. In addition, tritium has to be replenished.

There will consequently be facilities associated with fabrication, refabrication and storage of weapons material and the weapons themselves, that would exist outside the FMT as long as there are nuclear weapons.

(b) Facilities for dismantling nuclear weapons agreed to under disarmament (or voluntary) undertakings would most probably also not be accessible to international inspections due to proliferation concerns.

(c) Fuel fabrication for military naval reactors, would also not be accessible for reasons discussed above.

28. In summary, what would not be covered by the FMT would probably be :

(a) Weapons-grade material in existing weapons and in reserve for such weapons;
(b) Associated fabrication, refabrication and storage facilities;
(c) Facilities for the active dismantling of obsolete and redundant weapons, as well as those agreed to in terms of disarmament undertakings; and
(d) Fuel fabrication and reprocessing facilities associated with military naval reactors.

What could be covered by the FMT

29. Production facilities for the nuclear materials agreed to under the FMT will obviously be closed down/decommissioned[1]. It is possible that certain redundant fabrication or refabrication facilities will also be closed down. In addition certain facilities will be required to store the nuclear components declared as excess in their original geometrical or compositional forms. If these components are to be reworked to a less sensitive form, dedicated facilities may be employed for that purpose.

30. It is evident that most of these facilities and the warheads themselves may contain very sensitive information from a proliferation point of view. A special verification regime (no direct access for measurements, managed access in certain areas, etc) will be necessary with the prime purpose to ensure irreversibility, i.e that material declared as excess does not return to the weapons/military domain and facilities are not re-used for their original weapons-related purposes.

31. In summary :

[1] See IAEA definitions as they appear in the Additional Protocol (INFCIRC/540), namely:
Closed-down facility: An installation where operations have been stopped and the nuclear material removed but which has not been decommissioned.
Decommissioned facility: An installation at which residual structures and equipment essential for its use have been removed or rendered inoperable so that it is not used to store and can no longer be used to handle, process or utilise nuclear material.

(a) The type of 'fissile material' agreed to under the FMT will no longer be produced (probably only HEU and weapons-grade Pu). However, if fresh HEU needs to be produced for use in naval reactors, it will be done under strict verification.

(b) Material declared as excess (the result of parallel disarmament undertakings) would be covered by the FMT and be subject to appropriate verification.

(c) Facilities that will be closed down/decommissioned in terms of the Treaty and facilities for reworking the material which has been declared as excess and which is still in sensitive forms should be subject to appropriate verification.

(d) The verification regime would consequently have to be adapted to minimize proliferation concerns.

(e) The main purpose of verification will be to ensure irreversibility (materials and facilities).

Excess material in non-sensitive form

32. Once original weapons material has been reworked into a less sensitive form, it can be introduced into the verification system as new nuclear material. Since it would be HEU or predominantly Pu239, the material would probably be downgraded (to LEU in the case of HEU) or used for the production of MOX (mixed oxide) fuel as the need arises. The rest of the material will be stored under normal verification conditions. These processes or the storage of the material should be subject to verification similar to IAEA safeguards.

33. As more and more material is transferred from the military to the civil domain, this material could be used in power reactors after suitable fuel fabrication. This could impact on the need for the production of new low enriched uranium from source material and reprocessing of spent fuel for the recovery of unused U235 and newly produced Pu. However, it would not obviate the need for enrichment and reprocessing capabilities in the long-term and these activities should therefore be allowed to continue under normal safeguards verification procedures. The FMT should not prohibit these activities - adequate safeguards measures exist to ensure that enrichment and reprocessing facilities are not used contrary to non-proliferation requirements.

THE INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA) AS A POTENTIAL VERIFICATION ORGANISATION FOR THE FMT

34. In spite of the fact that verification of the FMT will in practice have a significant impact only on those few States that produce or possess nuclear weapons and/or weapons-grade materials, verification by the IAEA could mean a 2 to 3 fold increase in the Safeguards budget because of the extended nuclear activities of these States. This will create its own problems amongst the Member States of the IAEA. Creating a new verification

organization may be even more costly. Another serious problem is the unavailability of adequately trained and experienced inspectors. This could create serious problems if the number of IAEA inspectors has to be doubled, say, in the short term.

35. Some of the problems may be addressed in the following ways:

(a) Budget costs : The FMT could have its own budget. The IAEA could then be contracted for its verification service. This would avoid the traditional problem of linkage between the Safeguards and Technical Cooperation budgets in the IAEA.

(b) The costs of verification : Given the large quantities of new material and number of additional facilities to be covered it is unavoidable that the costs of IAEA safeguards implementation will have to be fundamentally reviewed. This can be done through legal rights that the IAEA always had but never exercised; new rights acquired by the Agency in terms of the Aditional Protocol; and the use of new technological advances.

(c) Availability of inspectors : There is no short-term solution for this problem. A build-up of the required number of inspectors will have to be a combined effort between the IAEA and its Member States and could take several years.

36. The adoption of the Integrated Safeguards System under the umbrella of Strengthened Safeguards, already provides for the reduction of traditional safeguards verification activities under certain conditions. This should be even further developed in view of the possible additional burden of the FMT, the main focus being on the verification of nuclear materials which are of real proliferation concern.

CONCLUSIONS

37. It is accepted that the FMT would be a significant step in the process leading to nuclear disarmament.

38. A clear understanding should be reached on which "fissile materials" should be covered by the treaty.

39. In addition to a ban on the further production of nuclear materials for nuclear weapons, the FMT's other main function would be to act as a receptacle for excess weapons material and associated closed-down/decommissioned facilities, in transition from military explosive use to peaceful use, to ensure the irreversibility of the transition.

40. The IAEA has the potential to take-up the responsibility for verification of FMT undertakings but certain proliferation and resource constraints will have to be addressed.

41. Once the nuclear material of weapons origin has passed into the peaceful, safeguarded, domain (together with the associated facilities) this could overburden the existing IAEA safeguards verification regime and adjustments will have to be made to the traditional way in which, for example, safeguards are implemented - e.g. with regard to the treatment of all plutonium (weapons- and reactor-grade) as weapons-usable material.

42. Declarations of historical production could be seen as a political gesture of goodwill although the practical difficulties regarding completeness will need to be acknowledged.

43. The production of tritium in civil power reactors for use in nuclear explosive devices and the production of nuclear material for naval reactors will require special consideration in the FMT.